Enhancement of Nutritional Value of Whey using Herbs and Spices

A

Synopsis

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Introduction

India is the largest milk producing country with milk production in 2017- 2018 being 176.3 Million Tonnes with per capita availability of 375 gms/day (www.nddb.org/information/stats/milkprodindia). Milk is the normal mammary secretion derived from complete milking of a healthy milch animal without either addition thereto or extraction therefrom and is free from colostrum (FSSAI, 2011). It is the primary source of nutrition for young mammals before they are able to digest other types of food. Milk provides complete nutrition in a balanced proportion, providing protein (casein), carbohydrate (lactose), calcium, vitamins B complex (thiamin, riboflavin, niacin, vitamin B_6, and folate), vitamin A, vitamin C, zinc, and magnesium (Davoodi et al., 2013). Full cream milk (6% fat and 9% SNF) also provides essential fatty acids, conjugated linoleic acid (CLA) present as minor component of milk fat is an antioxidant (Jelen 2005).

Milk is commonly used for preparing various types of products known as milk products which may contain food additives and other ingredients as permitted by FSSAI regulation (FSSAI, 2011). These milk products are curd, yoghurt, paneer, cheese, chhana, skimmed-milk chhana, condensed milk-sweetened and unsweetened, cream, Kalakand, skimmed milk curd, dahi, ghee, butter oil, ice-cream, infant milk food, khoa, malai, milk derivatives such as whey protein concentrate, whey protein isolate, casein, lactose, milk ices, milk lollies, kulfi, milk powder, skimmed milk powder (SMP), partly skimmed milk powder, processed cheese, table butter and white (industrial) butter (FSSAI, 2011).

Paneer is a traditional milk product obtained by heating and coagulation of milk at a suitable temperature by using suitable coagulant such as lactic acid, citric acid, tartaric acid, alum, sour whey. Heating of milk increases interaction of ß-lactoglobulin with κ-casein and the complex formed between ß-lactoglobulin and α-lactalbumin retards colloidal calcium phosphate solubility. Acidification precipitates casein micelles along with denatured whey proteins and insoluble calcium phosphate (Kumar et al., 2014). Temperature of coagulation affect the moisture content, fat and TS recovery and paneer yield. Paneer is an excellent source of protein which is accessible at very cheap price. About 5% of milk in India is used into paneer production (Khan and Pal, 2011) and rate of paneer production is increasing with 13% growth rate annually (Joshi 2007; Shrivastava and Goyal 2007). During the preparation of paneer, whey is the main bypoduct which is not used efficiently.

Whey is the liquid fraction of milk obtained during preparation of paneer, chhana, chakka, casein, cheese and other products. Whey has rich nutritional value as food supplement. It contains 70-72% lactose, 8-10% whey protein and 12-15% minerals (Gupta, 2000). Whey contains two types of proteins, major (α-lactalbumin-25%, β-lactoglobulin-65% and serum protein-8%) and minor proteins (Glycomacropeptide (GMP), bovine serum albumin, lactoferrin, immunoglobulin and phospho lipoproteins). Whey also contains water solubilized vitamins like cobalamine (vitamin B12), pyridoxine (vitamin B6), pantothenic acid (vitamin B5), riboflavin (vitamin B2), thiamine (vitamin B1), nicotinic acid (vitamin B3) and folic acid (Zadow, 1992). It is a good source of Branched Chain Amino Acids (BCAA) and are essential for athletes because Branched Chain Amino Acids are metabolized directly into muscle tissue and are the first ones used during exercise and resistance training (Kumar et al., 2018). All these nutrients have an indispensable value in human diet requirement (Prendergast, 1985).

Whey is used as a base material in the production of alcoholic, non-alcoholic, fermented, non-fermented and carbonated beverages (Holsinger et al., 1974). All over the world approximately 180-190 Million Tonnes per year whey is produced (Yadav et al., 2015). All over the world, about 40% of the total global production of whey is disposed as raw whey (Reddy et al., 1987). In India, about 5 Million Tonnes per annum whey is produced of which 80 per cent of total whey is from channa and paneer production and large portion of it is disposed of as a waste (Macwan et al., 2016).

Water Pollution Research Laboratory estimated that whey has a Biological Oxygen Demand (BOD) of 38,000 to 46,000ppm, as compared to permissible limit of 200 ppm for domestic sewage (Raj et al., 2017). So, whey is a very serious pollutant, therefore it should be either treated before disposal to reduce pollution load or used to obtain commercial products. As per Environmental Protection Act in 1986, it is mandatory to treat whey before discharge into land water or rivers (Singh and Singh, 2012). Disposal of whey is not an economically favourable activity for dairy industry and treatment of whey is also an expensive process and acts as extra burden on dairy industries. So, utilization of whey as a beverage is a feasible solution. Conversion of whey into beverage by adding different nutritional ingredient is one of the most attractive avenues for the utilization of whey for human consumption (Satpute et al., 2018). This whey-based beverage has many qualities and advantages because whey is a good source of

electrolytes such as potassium and sodium having role in retaining water in body and hence prevention against diarrhoea and dehydration.

Whey and its biological components have also proven effective in treatments of several chronic diseases like diarrhoea, bile illness, skin problems, scales in the urinary tract, cancer, hypertension and cardiovascular disorders (Ashoush et al., 2013; Kerasioti et al., 2014). Whey beverages have been recognized as a genuine thirst quencher, light, refreshing, healthful and nutritious drink.

Whey beverages are well accepted and recognized globally and have a great market potential. The total global beverages industry had a business of around $1,755.4 billion in 2010, which is expected to increase the value of the industry to about $2,072.9 billion by the end of 2016 (RS et al., 2015).

Utilization of whey

In India, the whey is not utilized in a proper stratergic manner. The total worldwide production of whey is an estimated about 180-190 million tonnes per year (Yadav et al., 2015). Indian dairy industries produced more than 3 Million Tonnes of whey per year, while more than 2 lakh tones is dumped into gutter due to costly processing techniques (Macwan et al., 2016). About 70% of whey is used to prepare different products such as protein concentrate, protein hydrolates, protein isolates, beverages and about 30% of whey is still being utilized for animal feeding, spread on agricultural land as fertilizer or even dumped into the rivers or the sea (Jelen, 2005). Whey processing is economically unfavourable, especially for small industries. It is also limited due to less demand for whey powder and further processed whey products (Jelen & Le Maguer, 1976).

Over the last few decades, utilization of whey in a efficient manner has gained importance because it has lagre nutritive value and is utilized to develop products. In USA, about 50% of the total produced whey is processed into whey protein concentrate (WPC), lactose and other products (Clark, 1987).

Objectives of the Study

In India, traditional sector is the main source of whey and it is directly disposed off as waste. Whey is a good source of protein, carbohydrate (lactose), vitamins and minerals and should be used in human food chain. In view of the importance of whey the present study has been undertaken with the following objectives: -

The major objectives of this study will be:

1. To produce whey using different coagulants and check its composition.
2. To develope whey beverage using extract of herbs and spices.
3. To improve shelf life of whey-based beverage and analysis of cost of beverage.
4. To develope whey concentrate and isolate whey proteins.

Significance of the work

India is the largest milk producer in the world (176.3 Million Tonnes in 2017-2018). Approximately 5% of milk produced in India is used to paneer production. In India, paneer is the major source of whey and it is highly nutritious.Traditional and unorganised sector disposed whey directly into sewage and land. It creates a serious pollution and loss of nutrition. Thus, the present study aims to accomplish the above-mentioned objectives for the following expect desirables:

1. Reduce the risk of sewage and inland pollution.
2. Increase the traditional sector income by using whey as waste to a valuable product.
3. Enhance nutritional value of paneer whey using flavoured herbs/spices and utilization as beverages.
4. Increase utilization of whey concentration and whey proteins.

Review of Literature

Studies show that whey has rich nutrient profile and it is not considered as a waste. Whey is used to prepare valuable products such as protein concentrate, protein isolate, lactose production, vitamin production, lactic acid production and beverages.

Whetstine et al., (2005) repoted that raw whey is converted into dried powder, protein concentrates, and protein isolates. And studied the different aroma factor between whey protein concentrate 80 and whey protein isolate. They concluded that flavour was found varied between protein concentration and protein isolate from different manufacturers. Whey is also used to production of vitamin B compex by using *Propionibacterium freudenreichii ssp. Shermanii* (use lactose as a main carbon source and able to grow in whey) by fermentation process and further study show that condensed milk whey (nutrient media) increases the vitamin production (Shershenkov and Suchkova, 2015). Whey is also used preparing different type of beverage or drinks.

Jindal et al., (2004) used chhana and paneer whey in the development of sweet and salty pancakes. They studied the various factor such as pH, acidity, total solid, protein content, overall acceptability and sensory. They concluded that puras containing the 80/20 (whey/water) scored maximum for appearance, texture, flavor, taste and overall acceptability. Acid whey had been found most suitable for blending with fruit juices to produce cloudy fruit drinks (Tuohy et al., 1988). Citrus fruits juice is commonly using for development of whey beverage. A group of researchers developed whey beverage using pomegranate juice at different concentration in chakka whey and evaluate the various factor like electrolytes concentration, total sugar, protein content, sensory evaluation using nine-point Hedonic scale and overall acceptability. Out of them T3 scored highest and highest acceptability (Babar et al., 2008).

At NDRI campus, **Goyal and Gandhi (2009)** studied paneer whey and cheese whey using various parameters for making electrolytes whey drinks is a good source of sodium, potassium, magnesium, calcium and zinc and it can be analyzed by atomic absorption spectroscopic method. Studies showed that acid whey is a good source of electrolytes with comparison of sweet whey.

Whey beverages were prepared using pineapple juice at different levels [(T0)0,5(T1), 10(T2), 15(T3)] at 8% sugar in chhana whey. Pineapple is a good source of antioxidant. After that analysis of overall acceptability (color, consistency, mouth feel, flavor), physical parameters (viscosity, pH, Titratable acidity) and chemical composition (moisture, Total solid, fat, protein, carbohydrate, ash) (Bhavasagaret al., 2010). Singh and Singh (2012) had been prepared instant energy beverage using mango pulp and stabilizer for hard working group of people. Mango pulp concentration, stabilizer and sucrose added in beverage were optimized by the utilization of Response Surface Methodology.

Another group of researchers studied the effect on stability of artificial sweeteners (aspartame, acesulfame-k) during storage in whey lemon beverage. HPLC analysis showed that artificial sweetener was stable in beverage under refrigerated condition for 15 days (Arora et al., 2013). Bhat and Singh (2014) tried to develop a beverage using whey and guava, guava which is a good source of vitamin, carotenoids, folate, potassium, fiber, calcium and iron. As a result of storage there was an increasing trend in TSS, acidity, reducing sugar and a decreasing trend in the pH, lactose and ascorbic acid.

A group of researchers used whey as a base material for the preparation of low- calorie high-fiber whey-based watermelon beverage. Independent variables like whey, fiber and sucralose were chosen at different levels and studied the effect of variables on flavor, after-taste, mouthfeel, viscosity, total soluble solid (all to be maximized) and sedimentation (to be minimized) was observed. The level of processing parameters was optimized by Response surface methodology (Saxena et al., 2015).

In a study, cheese whey and paneer whey used for the development of pineapple whey beverage and comparatively studied both the beverages at different levels of content of protein, total phenolic, reducing sugar, ash, ascorbic acid and minerals. Result showed that both paneer whey and cheese whey contained better protein content and paneer whey beverage showed highest mineral content and better overall acceptability (Baba et al., 2016).

Using acid whey (paneer or casein whey) as base material for the production of fruit based beverage. Fruit based whey beverage has great market potential. Formulation of papaya ready to serve beverage using dairy industry waste (whey), in which different proportion of water is replace by whey (0, 25, 50, 75, 100) and 10% of papaya pulp is added. Result showed that 25% addition of whey beverage highly acceptable (Panghal et al., 2017). A group of researchers prepared a beverage by using beetroot extract and menthol (2-6%) at four different concentration combinations such as T-1 (80% whey with 20% beetroot extract), T-2 (80% whey with 20% beetroot extract and 2% Mentha extract), T-3 (80% whey with 20% beetroot extract and 4% Mentha extract), T-4 (80% whey with beetroot extract and 6% Mentha extract). They concluded that beverage (80% whey with beetroot extract and 6% Mentha extract) contains high overall acceptability and sensory quality (Satpute et al., 2018). All these studies showed that nutritional value of whey using fruits and herb can be enhanced and preparation of beverage feasible solution of disposal of whey.

Enhance nutritional value of whey with using herbs and spices

Since vedic times many herbs and spices are used to enhance the nutritional value of food. These herbs and spices were also extensively used to cure many diseases and disorders. These herbs and spices contain various type of nutrients and secondary metabolites. So, these herbs and spices are feasible to enhance nutitional value of whey.

The major herbs and spices that are commonly available in India are:

1. Black Pepper (*Piper nigrum*, Piperaceae; Kali Mirch)

It contains a bioactive phytochemical, piperine. Piperine inhibits free radicals and reactive oxygen species and lipid peroxidation due to their flavonoids and phenolic contents. It has also been shown based on modern cell, animal, and human studies that piperine has immunomodulatory, antioxidant, anticarcinogenic, and anti-inflammatory properties (Bang et al., 2009).

2. Vanilla (*Vanilla planifolia*,Orchidaceae)

It is the most popular because of its desirable aroma and flavor. The main constituent of Vanilla is vanillin, which constitutes 85 % of the entire volatiles in Vanilla beans. The other constituents reported are vanillic acid, hydroxy benzoic acid, phenols, mineral salts like magnesium, calcium, zinc manganese, potassium and iron (Belay et al., 1993). It is used for respiratory pain, deep coughs, stomach ailments etc. Vanillin is used extensively as flavoring agent in food, beverage, perfumery and pharmaceutical industries (Shyamala et al., 2007).

3. Cardamom (*Elettaria cardamomum*, Zinziberaceae; Elaichi)

It is widly use for culinary purpose. It has diuretic, antibacterial, antiviral, antifungal properties and considered useful in treatment of constipation, diarrhea, dyspepsia, vomiting, headache, epilepsy and cardiovascular diseases. It also increases gastric secretion (Gilani et al., 2008).

4. Cinnamon (*Cinnamomum verum*, Lauraceae; Dalchini)

The most important constituents of cinnamon are cinnamaldehyde and trans-cinnamaldehyde (Cin), which are present in the essential oil. It is used to improve the health of the colon. Cinnamon also increases the blood circulation in the uterus and advances tissue regeneration (Rao and Gan, 2014).

5. Fennel (*Foeniculum officinale*, Apiaceae; Saunf)

Fennels contain high dietary fiber and vitamins, relative to human needs. Fennels are one of the highest plant sources of potassium, sodium, phosphorus, and calcium. It is used to treat cough/cold, cuts and complicated ailments like kidney ailments. It is extensively used to increasing the quantity and quality of milk but also for improving the milk flow of breastfeeding mothers (Badgujar et al., 2014).

6. Basil (*Ocimum basilicum*, Lamiaceae; Tulsi)

Traditionally it is used to treat of headaches, coughs, diarrhea, constipation, warts, worms and kidney malfunctions. It has also antioxidant property (Politeoet al., 1998).

7. Dates (*Phoenix dactylifera*, Arecaceae; Khajoor*)*

Date fruit is a good source of fiber, and contains many important vitamins and minerals such as calcium, iron, fluorine and selenium etc (Tang et al., 2013).

8. Stevia (*Stevia rebaudiana*, Asteraceae)

It is used in many parts of the world as a non-caloric sweetener. It has antioxidants and used to relieve blood pressure, hypertension and weight loss (Goyal et al., 2010).

Proposed methodology

On the basis of literature review, whey is rich source of protein, carbohydrate (lactose), vitamins, minerals. Whey is used preparing protein powder, protein concentration, protein isolate, vitamins, energy drinks, herbal beverage and more. Howerver whey itself is a packet of so many health promoting qualities but addition of herbes and spices will enhance them.

Preparation of whey as per the method used by Bhavsagar et al., (2010).

- Collect raw milk
- Pre-heating
- Filtration
- Pasteurization
- Addition of coagulants
- Curd mass
- Whey removal

Preparation of suitable herbal extract as per method used by Satpute et al., (2018).

- Selection of herbs
- Washing
- Grinding
- Filtration

Preparation of herbal whey beverage as per the method used by Panghal et al., (2017).

- Fresh paneer whey
- Filtration

- Addition of sugar syrup
- Addition of herbs extract
- Addition of stabilizers
- Filling in bottles
- Crown capping
- Pasteurization
- Storage

Isolation of whey protein as per the method used by Mao et al., (2017).

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